The photo-induced $K^*$ vector meson production is investigated for the study of $\Lambda(1405)$. This reaction is particularly suited to the isolation of the second pole in the $\Lambda(1405)$ region which couples dominantly to the $K\Lambda$ channel. We obtained the mass distribution of the $\Lambda(1405)$ which peaks at 1420 MeV, and differs from the nominal one.

**Motivation: Two poles?**

There are two poles of the scattering amplitude around nominal $\Lambda(1405)$ energy region.

**Cloudy bag model (1990)**

J. Fink et al. PAC 41, 2720

**Chiral unitary model (2000-)**

J. A. Oller et al. PRB506, 263
E. Oset et al. PLB527, 99
D. Jido et al. PRC66, 025203
T. Hyodo et al. PRC68, 018201
C. Garcia-Recio et al. PRD87, 076009
D. Jido et al. NPA725, 181
T. Hyodo et al. PRC68, 052003

**Diagram of the reaction**

Diagram of the reaction $\pi^0, \pi^+$

$K^+_\Lambda(1405)$ pole term

**Isospin decomposition of $\pi\Sigma$ states**

$\frac{d\sigma(\pi^0\Sigma)}{dM_2} \sim \frac{1}{3} ( |T_{\pi^0\Sigma}^{(0)}|^2 + |T_{\pi^0\Sigma}^{(1)}|^2 + \frac{6}{\sqrt{6}} Re(T_{\pi^0\Sigma}^{(0)}T_{\pi^0\Sigma}^{(1)*}) )$

$\frac{d\sigma(\pi^+\Sigma)}{dM_2} \sim \frac{1}{3} |T_{\pi^+\Sigma}^{(0)}|^2$

pure $I=0$ amplitude

**Numerical results**

Invariant mass distributions for several channels

**$\Lambda(1405)$ in the chiral unitary model**

Two poles: $1390 + 66i \ (\pi\Sigma), \ 1426 + 16i \ (K\Lambda)$

**Conclusions**

We study the structure of $\Lambda(1405)$ using the chiral unitary model.

There are two poles in the scattering amplitude around nominal $\Lambda(1405)$.

- $1390 + 66i$: strongly couples to $\pi\Sigma$
- $1426 + 16i$: strongly couples to $K\Lambda$

By observing the charged $\pi\Sigma$ states in $pp \to K^+\Lambda(1405)$, it is possible to isolate the higher energy pole.

If we observe the neutral $\pi\Sigma$ state, clear $I=0$ distribution is obtained.